1076538 - R8 SDMS

ADMINISTRATIVE RECORD

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
DENVER, CO 80202-1129
Phone 800-227-8917
http://www.epa.gov/region08

Ref: Libby Ambient Air Sampling

MEMORANDUM

SUBJECT: Minimum Face Velocity for Asbestos Sampling Cassette

FROM: Robert Edgar

TO: Mary Goldade

Mary - During our last meeting with Bill Brattin, the question arose over why the minimum face velocity for the sampling of asbestos as stated in ISO 10312 was 4.0 cm/sec. As shown in the attached figure (from Air Pollution - Its Origin and Control), the terminal or settling velocity of a spherical particle with a diameter of 0.3 microns is 4 cm/sec if the particle has a density of 1.5 g/cm3. If the same size particle has a density greater than 1.5 g/cm^3, its settling velocity would be greater than 4 cm/sec, and therefore, with the sampler pointed downward this particle would not be captured if the flowrate was less than 4 cm/sec in the cassette. For spherical particles with a diameter of 0.3 microns and a density less than 1.5 g/cm^3, they would be captured with a 4 cm/sec face velocity in the sampling cassette. Aerodynamic equivalent diameters for non-spherical particles are calculated equating their volumes to a spherical particle with the same volume. Therefore, the minimum face velocity of 4.0 cm/sec for asbestos sampling is likely related to the density and aerodynamic equivalent diameters for asbestos particles.

Printed on Recycled Paper

‌uation (5-27), the Cunningham factor increases rapidly as the particle lecreases and approaches the mean free path. When d_p is 10 μm, the ction is less than 2 percent. However, for a 1 μm-diameter particle the of V_t will be over 15 percent greater than the Stokes' law value. The onship of V_t at these small sizes is

$$V_t = K_C V_{t,\,\text{Stokes}} \tag{5-31}$$

t is known as the Stokes-Cunningham law.

In the transition region between laminar and turbulent flow around a ical particle the standard drag coefficient curve can be modeled by the ssion

$$C_D = 0.22 + \frac{24}{\text{Re}}\left[1 + 0.15(\text{Re})^{0.6}\right] \tag{5-32}$$

equation for flow around spheres is valid for Reynolds numbers from 1 0. When the Reynolds number is greater than 0.5 (or the particle size ciably greater than 50 μm), it is convenient to use the experimental e data directly to evaluate V_t versus d_p at various particle densities, and present the results graphically. This is done in Figure 5-8, which covers article-size range from 0.1 to 3000 μm on a log-log plot. The terminal or ng velocity varies between 10^{-3} to 10^3 cm/s. For particle sizes above m (or for Reynolds numbers greater than roughly 0.1) four curves are n, for particle densities of 1.0, 1.5, 2.0, and 3.0 g/cm^3. (For these es, the left and upper axes must be used.) The single line to the right sents the Stokes and Stokes-Cunningham regions of flow. Note that the lating line is essentially straight between V_t values of 5×10^{-3} and 1 s, as predicted by Stokes' law for a log-log plot. Below 5×10^{-3} cm/s ine curves as a result of the Cunningham correction. This single line is only for spherical particles with an apparent density of 1 g/cm^3. From ation (5-26) we note that V_t is proportional to ρ. Thus the terminal city in the Stokes region for other particle densities may be found by the ion

$$V_t(\text{at } \rho_p) = V_t(\text{at } \rho_p \text{ of } 1 \text{ g/cm}^3) \times \rho_p \tag{5-33}$$

re the first term on the right is found directly from Figure 5-8. It should oted that Figure 5-8 is valid only for spherical particles settling in air at n temperature and pressure.

nple 5-3

llustrate the evaluation of terminal velocities, assume a particle with unit sity (1 g/cm^3) and a diameter of (a) 10, (b) 100, and (c) 1000 μm. mate the terminal velocity in room air in centimeters per second. Also

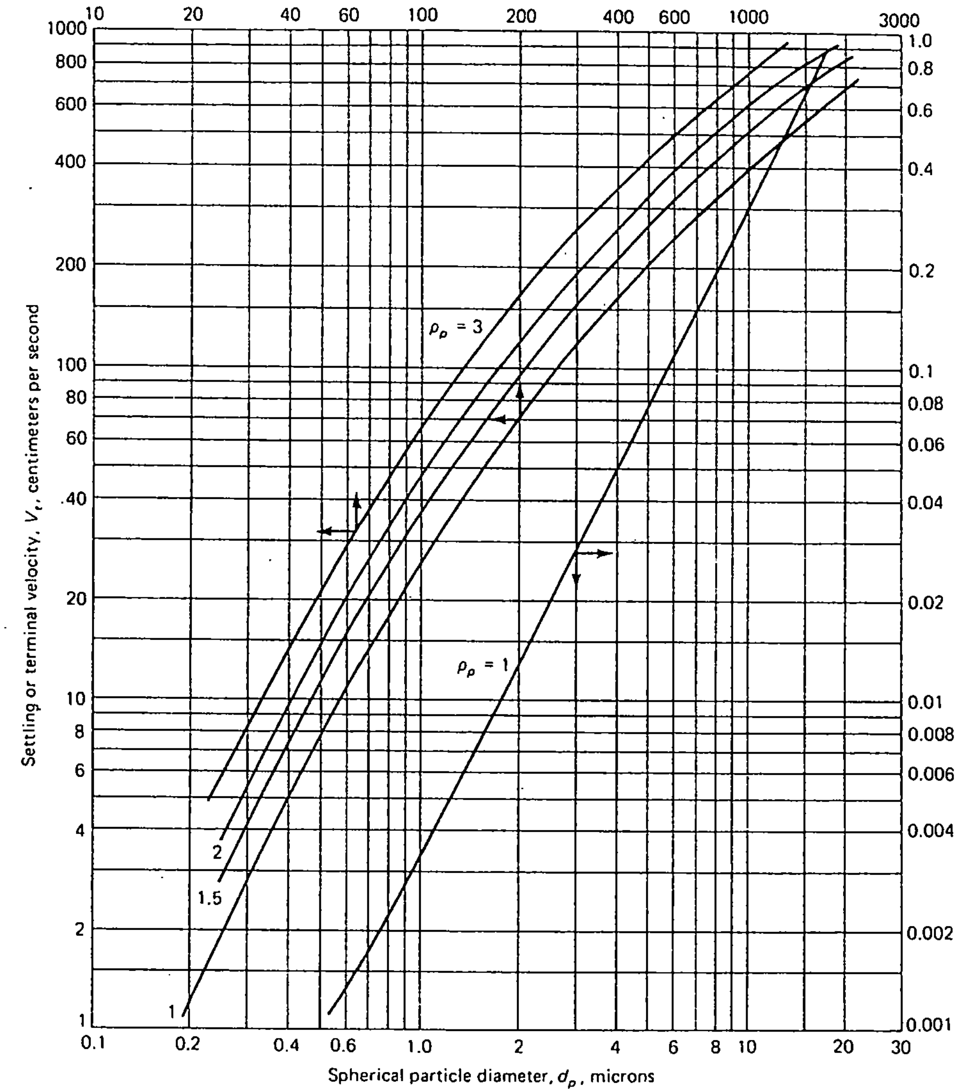

Figure 5-8 The terminal or settling velocity of spherical particles in atmospheric air at room temperature (density in grams per cubic centimeter).

SOLUTION

The terminal velocities can be read directly from Figure 5-8 in the required units. From this figure, as an estimate,

$$\begin{aligned} d_p &= 10\ \mu\text{m}, & V_t &= 0.3 \text{ cm/s} \\ &= 100\ \mu\text{m}, & &= 25.5 \text{ cm/s} \\ &= 1000\ \mu\text{m}, & &= 400 \text{ cm/s} \end{aligned}$$